

THE PRESENT STATUS AND FUTURE PROSPECTS OF RADIATION VULCANIZATION OF NATURAL RUBBER LATEX

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Extensive research on radiation vulcanization was carried out in France in the 1960's. Their main conclusions after years of study were very discouraging. They concluded that the process is complicated, not economic and not safe. An amazing revival of the radiation vulcanization technology was set in motion in 1978 through financial support from IAEA/UNDP. One of the major programmes in the Regional Corporation Agreement (RCA) project was the development of radiation vulcanization technology which would ultimately benefit several Asian countries in the region. This regional study would ultimately enhance Natural Rubber's (NR's) competitive position with respect to Synthetic Rubber (SR). Now, for nearly 10 years the RCA countries in South East Asia have been engaged in the development of radiation vulcanization technology, with Takasaki Radiation Chemistry Research Establishment (TRCRE), Japan and the Centre for Atomic Energy and Isotope Research (CAIR) Batan, Indonesia, providing the facilities for the development of the technology and the training of personnel for the project. Each of the RCA countries including the latest to join in the RCA project, Peoples Republic of China have had the opportunity to send officers for training and to carry out research and development work to develop the technology. Sri Lanka is most fortunate that five officers have been directly involved in the project and had used the facilities available in Takasaki or in Batan for periods of six to twelve months; under IAEA fellowships.

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In Japan a company by the name of Okimoto Ricken has perfected the technique of manufacture of protective gloves using Radiation Vulcanized Natural Rubber Latex (RVNRL) after being able to overcome the problem of tackiness in the finished product. Upto 5 Million pairs have been produced since March 1989 for a nuclear plant in Japan. In the nuclear plant they prefer to use protective gloves made from RVNRL even after paying seven times more for the product due to the lessening of toxic gases evolved during incineration of discarded gloves. Sulphur dioxide and other gases liberated from gloves manufactured from the conventional sulphur vulcanized latex are not only toxic but they also foul the chimneys which carry these gases during incineration. An analysis of the gases evolved during burning is given in table 1.

In Indonesia a 250,000 Curie Co - 60 irradiation facility is set up which can irradiate upto a one tonne batch of latex (dry) at a time. Down stream developments are taking place in Indonesia but the progress is very slow. A condom factory set up recently in Bandung has made several trial productions of condoms using RVNRL. They have not yet been able to fully overcome the problem of tackiness in the product.

IAEA is now keen to give more emphasis to Research and Development work at a national level. IAEA is keen to support national activities and will in future emphasise less on regional activities. The activities of National Research Group's (NRG's) will be strengthened. Sri Lanka is one of the first countries in the RCA group to set up a NRG with participation from the Rubber Research Institute (RRI), Ceylon Institute of Scientific and Industrial Research (CISIR), the Industrial Development Board (IDB) and the Atomic Energy Authority (AEA), and areas of research undertaken by these Institutions are clearly identified. The IDB will continue to look at down stream development projects. It is necessary to continue the R & D work to overcome the short comings as there are a number of clear advantages in radiation vulcanization technology. The advantages, when considering the total picture which includes both dry rubber and wet latex may be stated as;

1. High rate of vulcanization.
2. High utilisation of Energy.
3. Economy of Space in Production.
4. Less Pollution.
5. Amendable to automation and continuous production.
6. Reduced scrap losses.
7. Low Toxicity.
8. Absence of Sulphur & Zno.
9. Transparency.
10. Softness.

The development of the R & D programme and the activities of the NRG will be highlighted in a series of seminars from time to time. The first of such a series was held in November 1988. This seminar is the second in the series and this will be followed by a National Executive Seminar on radiation vulcanization fixed for December 1989, with full participation by the IAEA. The executives in the Industry will be the main participants. They will be made aware of the progress so that effective transfer of technology will result once the technology is perfected.

The present status of the NR latex industry would reveal the trends for future development of this sector. Production of NR latex concentrate world wide is currently at approximately 500,000 t.

A 60% of this amount which is 3,000,000 t. is used for dipped products manufacture and the balance 40% which amounts to about 200,000 t is used in miscellaneous applications such as adhesives, extruded thread carpet backing etc. In the dipped product sector there is an upward trend in demand for gloves of all types, the most important being dispersible examination gloves. The market situation which existed in 1988 resulted in several production lines being set up mainly in Malaysia. It was a booming industry which survived only for a short time because quality requirements were neglected in the thirst to make quick money. It is now seen that the excess capacity for the production of low quality gloves is disappearing rapidly as more stringent demands for quality and reliability produce their inevitable effects. Only efficient manufacturers of high quality gloves will be able to compete for the markets in developed countries in the future.

The quality of the latex plays a very important role and reproductibility of process behaviours of latex concentrate is important. RVNRL has several attributes which have to be developed for its successful use in highly efficient production lines. More concentrated studies on the relationship between latex properties and processing performance is important.

Other important factors which needs consideration in the future prospects for NR latex includes such problems as cytotoxicity, environmental effect, and the incorporation of carcinogenic additives in product manufacture. Developments, such as radiation cross linking, should be welcomed in so far as they offer the possibility of solving at least some of these problems. Urethral and urethral strictures caused by urinary catheters relates to cytotoxicity of the material used in the manufacture of catheters. Zinc diethyl dithiocarbamate which is widely used as an accelerator in sulphur vulcanization is believed to be the cause of this problem. Cytotoxicity is found to be very weak when RVNRL is used to make the catheters.

Consumption of NR latex is growing rapidly in Europe in spite of the competition from synthetic polymers such as Silicone rubber and polyurethane rubber. Environmental aspects will be uppermost in the choice of raw materials. From this year, in the Federal Republic of Germany, a new safety regulation will come into force concerning volatile Nitrosamines present

in the atmosphere inside rubber factories. Nitrosamine levels in the commonly used accelerators for sulphur vulcanisation are given in table 1. Limits of Nitrosamine allowed in various products used by babies and in medical and food applications are given in table 1. In future the level of both nitrosatable material and nitrosamines will be a critical factor in the choice of raw materials for rubber product manufacture and it is here that production from RVNRSL has the edge over the conventional sulphur vulcanized NR products. A new development should be cost effective. Attempts to reduce the cost of irradiation have been mainly concentrated in the development of sensitizers added to the latex to promote radiation cross linking and reduce the radiation dose required, to achieve optimum physical properties. This has been achieved to a large extent. A newly designed low cost irradiator developed by the Bhabha Atomic Energy Research Institute in India will be tried out both in India and Malaysia. It is argued that the electron beam machine (EBM) would be cheaper than the Co - 60 irradiator. However, not much information is available in the use of the EBM for radiator vulcanization of latex. Recent studies carried out in Japan, Federal Republic of Germany and the Peoples Republic of China are reported. A cost comparison of the EBM and Co. - 60 irradiator is given in Table 1.

It is necessary to continue to make a concerted effort to develop RVNRL technology as the potential for RVNRL is tremendous especially in the immediate future. There is no substitute for market opportunity oriented R & D. We are hopeful that the efforts made by the AEA along with the RRI, CISIR and the IDB would make a substantial breakthrough in the development of this technology within the next two years.

REFERENCES

K. Makuuchi, Radiation vulcanization of Natural Rubber Latex (1989) (International Communication)

Table 1. *Comparison of radiation processing methods*

	Election Acclerator (Electron beam)	Cobalt 60 – Source (gamma rays)
Radiation energy for processing of NR latex	9.0 Mrads	1.5 Mrads
Through put of NR latex	0.32 t/hr/kw	0.24 t/hr/kw.
Effective energy out put	125 kw	16.667 kw.
Radiation Efficiency	80%	50%
Required energy output	150 kw	(2,250 Kci).
Initial cost of facility	Rs. 202,500,000	Rs. 321,250,000
Operationa cost/Annum.	Rs. 5,625,000	Rs. 17,550,000

(note prepared for the NRG meeting – July 1989 by TRCRE).